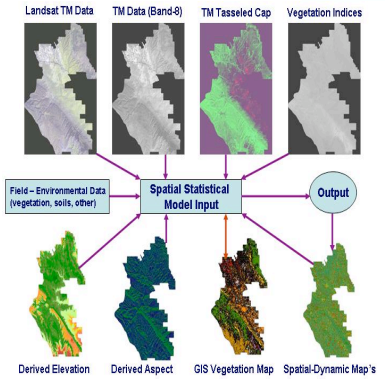
The Invasive Species Forecasting System: Space-Based Decision Support for Invasive Species Management

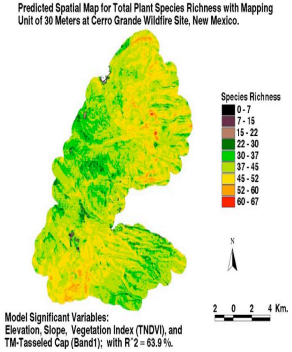
J.W. Closs[1, 2], N.F. Most[1, 4], D.J. Kendig[1, 2], M.A. Kalkhan[3], J.T. Morisette[1], J.A. Pedelty[1], T.J. Stohlgren[3] and J.L. Schnase[1].

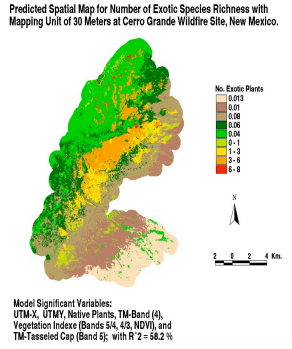
[1]NASA Goddard Space Flight Center, Earth and Space Data Computing Division, Greenbelt, MD
[2]Science Systems and Applications, Inc., Lanham, MD
[3]Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO
[4]Intelview, Greenbelt, MD

The NASA Office of Earth Science and the US Geological Survey are working together to develop a National Invasive Species Forecasting System for the detection, remediation, management, and control of invasive species on Department of Interior and adjacent lands. The project is a broadly interdisciplinary effort that brings together ecologists, scientists, statisticians, natural resource managers, policy makers and others who share an interest in the invasive species challenge.



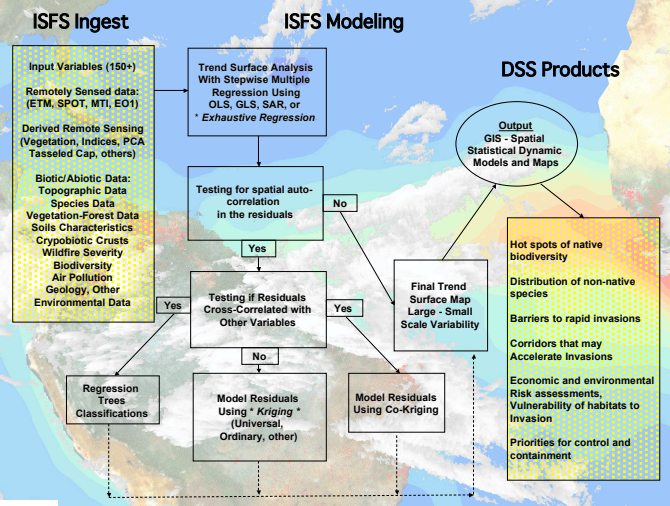
High resolution mapping of biological resources is central to confronting the invasive species threat and forms the basis of the Invasive Species Forecasting System. The ability to model small scale variability in landscape characteristics requires the generation of full coverage maps depicting characteristics measured in the field. While many spatial datasets describing land characteristics have proven reliable for macro scale ecological monitoring, these relatively coarse scale data fall short in providing the precision required by more refined ecosystem resource models. Spatial statistics and geostatistics provide a means of developing spatial models that can be used to correlate coarse scale geographical data with micro scale field measurements of biotic variables.





http://InvasiveSpecies.gsfc.nasa.gov

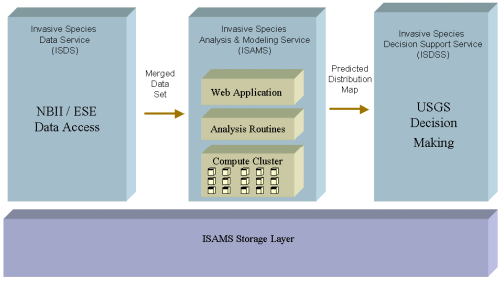
The ISFS is a Web-based information management and modeling environment tailored to the needs of the invasive species community. The system provides a framework for using USGS's early detection and monitoring protocols and predictive models to process MODIS, ETM+, ASTER and commercial remote sensing data, and create on-demand, regional-scale assessments of invasive species patterns and vulnerable habitats.



The USGS geostatistical process for creating predictive spatial models accepts as input a collection of ecological attributes, such as topographic data, species data, soil characteristics, ETM+ -derived vegetation indices, etc. These attributes are examined for statistically viable relationships between predictor variables and response variables. Trend surface analyses are performed, and residuals from the analyses are further analyzed for spatial structure using kriging and co-kriging (a spatial interpolator that determines the best linear unbiased estimate of the value at any given pixel in an output surface or image using a weighted sum of the values measured at arbitrary sample locations).

The results are brought together to produce a refined spatial prediction that is accompanied by an estimate of uncertainty. It is important to emphasize that the process's ability to produce both predictive maps and a maps of uncertainty significantly increases its value for decision support, since useful predictions are ultimately dependent upon a quantifiable understanding of error.

ISFS Services



ISFS Front End Layer:
Graphical User Interface offering users universal access to the system.

ISFS Application Layer:
Ingest — The ingest subsystem will serve as the initial "entry point" for all data used in the system, offering users the capability of uploading data to be used by the system and merging ingested datasets to create a data product that can be analyzed in the modeling step. The ingest subsystem is being designed as an independent service called the Invasive Species Data Service.
Modeling — The modeling subsystem allows users to apply high-performance statistical algorithms to predict the large-scale distribution of invasive species throughout a habitat of interest.
Decision Support System — Results from the modeling activities provide products in the form of images and corresponding data for user analysis in formal and informal decision support systems.

ISFS Back End/Storage Layer:
An archive subsystem coordinates interactions with databases to allow personal and public storage of data and modeling results.